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Aerospace Crew Equipment Laboratory

AN ENVIRONMENTAL WHOLE-BODY PLETHYSMOGRAPH

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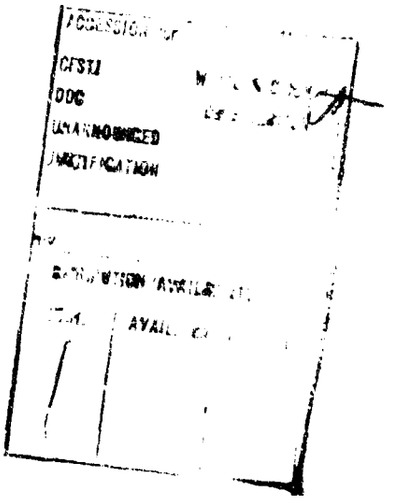

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Plethysmography
A.M., Tuesday
15 November

An Environmental Whole-Body Plethysmograph

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Whole body plethysmographs have been used to conveniently measure certain aspects of pulmonary function in man, including thoracic gas volumes and simultaneous airway resistances. These plethysmographs have been constructed for relatively short term occupancy and have been characterized by a gas-tight construction. We have constructed a whole-body plethysmograph which also functions as a controlled environmental chamber, capable of enclosing a subject for indefinitely extended periods. No attempt was made to make our plethysmograph gas-tight; on the contrary, by maintaining communication between the interior of the plethysmograph and the ambient environment, we have eliminated disturbing pressure effects due to changes in temperature and humidity within the enclosure.

Our plethysmograph was constructed of reinforced aluminum sheets (except for a reinforced plexiglas lid), to produce a box having overall dimensions of about 2.5 ft x 2.5 ft x 7 ft, and an internal volume of about 43.1 ft^3 (1220 L.). As shown in Fig. 1, the box is supported on a wheeled carriage and can be oriented so that the subject within is either recumbent, seated, or standing. Additional features include: ports on each side with attached sleeves through which the subject can extend his arms, with minimal contamination of the box atmosphere, for such purposes as the withdrawal of blood samples; a mouthpiece-tube-valve arrangement through which expired gases can be collected into a container located outside the box; a pipe with shower heads located within the box for fire-fighting (a rather unlikely event, but nevertheless possible when the box atmosphere contains increased concentrations of oxygen); a respiratory assembly supported by a jointed arm, consisting of a mouthpiece, a solenoid-activated shutter, a Fleisch pneumotachygraph, and a number of access tubes for pressure measurements; a variety of sensors for measuring box temperature, subject temperature, box humidity, gaseous composition and pressure; and a two-way communications system.

Recumbent subjects have been exposed in this plethysmograph for 12 hr periods at sea level in either air or oxygen, and at altitude (5 psia in a low pressure chamber) in oxygen.* Plethysmographic measurements of thoracic gas (lung) volumes and airways resistance have been carried out by shutting off gas flow into the box, and having the subjects pant through the respiratory assembly.

The plethysmograph is calibrated by pumping known gas volumes into and out of the box with a motor-driven syringe. Slowly changing box pressures due to temperature and humidity changes are relieved through an open valve, which exerts no appreciable effect on the rapid pressure changes upon which lung function measures are based.

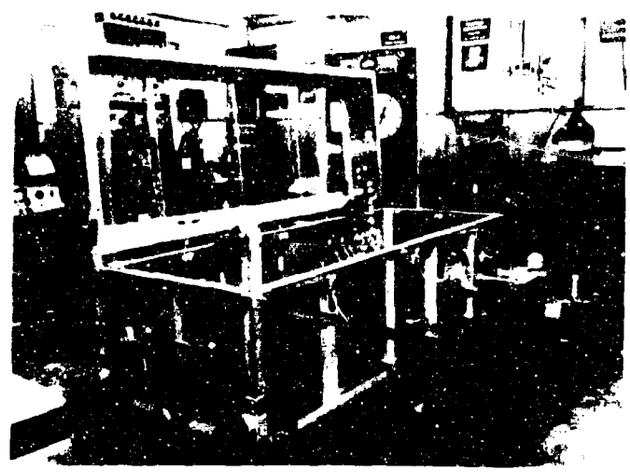

Fig. 1. Environmental Whole-Body Plethysmograph

For comparative purposes, the residual volumes of three supine subjects were determined using the body plethysmograph just described, and the open-circuit gas dilution technic. In addition, calculated values based upon sitting plethysmographic measures (courtesy of Dr. A. B. DuBois) and upon a formula based on age, sex, weight, and height, are shown in Table I.

TABLE I

SUPINE RESIDUAL VOLUME (L)

	Measured		Calculated	
Subj.	Pleth.	Gas Dil.	From Sitting	Formula
D	1.06	1.12	1.04	1.40
H	1.98	1.99	2.38	2.20
R	1.90	1.56	1.45	2.24

*In connection with studies being conducted under NASA DPR T-41832(G).

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13. ABSTRACT

A device is described which functions both as a whole-body plethysmograph and as an environmental chamber, in which human subjects can be confined for prolonged periods. This device has been used to make pulmonary function measures while subjects have been exposed over 12 hour periods to air and 100 per cent oxygen, both at sea level and at altitude.

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